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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte AART ZEGER VAN HALTEREN,
WILMINK ENGBERT, HENDRIK DOLLEMAN
and PAUL CHRISTIAAN VAN HAL

Appeal 2007-4432
Application 09/980,430
Technology Center 2600

Decided: June 10, 2008

Before ROBERT E. NAPPI, JOHN A. JEFFERY,
and CARLA M. KRIVAK, *Administrative Patent Judges*.

JEFFERY, *Administrative Patent Judge*.

DECISION ON APPEAL

Appellants appeal under 35 U.S.C. § 134 from the Examiner's rejection of claims 8-11 and 27-36.¹ We have jurisdiction under 35 U.S.C.

¹ Contrary to the Appeal Brief filed February 16, 2006 (App. Br. 2), claims 12-26 have been withdrawn from consideration and are not canceled. The Advisory Action, mailed September 2, 2004, indicates the Amendment

§ 6(b). We affirm-in-part and enter a new ground of rejection under 37 C.F.R. § 41.50(b).

STATEMENT OF THE CASE

Appellants invented a coil assembly for an electro-acoustic transducer. The assembly includes a coil having an opening defining a longitudinal axis and an electronic circuit board positioned against and adhered to the coil in essentially perpendicular relationship to the axis. The circuit board may include electronics for signal processing. This assembly reduces the labor and time involved in constructing the transducer.²

Claim 8 is illustrative:

8. A coil assembly for an electroacoustic transducer, comprising:

a coil having a coil opening defining an axis therethrough; and

an electric circuit board wherein at least a surface portion thereof is positioned against said coil in a substantially perpendicular relationship to said axis.

The Examiner relies on the following prior art references to show unpatentability:

Sone	US 5,432,758	Jul. 11, 1995
Lee	US 5,861,686	Jan. 19, 1999

under 37 C.F.R. § 1.116, filed July 19, 2004, has not been entered for purposes of appeal.

² See generally Spec. 2:1-3:6 and 4:14-5:6.

The following reference is cited in a new ground of rejection under 37 C.F.R. § 41.50(b):

“Linear Transverters for 144 and 220 MHz” in *The ARRL Handbook For Radio Amateurs 1993*, ch. 31, pp. 31-17 through 31-28 (Am. Radio Relay League) (17th ed. 1992).

The Examiner’s rejections are as follows:

1. Claim 28 stands rejected under 35 U.S.C. § 112, ¶2.
2. Claims 8, 9, 31, and 32 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Lee.
3. Claims 8, 10, 11, 27, 29-31, and 33-36 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Sone.³

Rather than repeat the arguments of Appellants or the Examiner, we refer to the Briefs⁴ and the Answer⁵ for their respective details. In this decision, we have considered only those arguments actually made by Appellants. Arguments, which Appellants could have made but did not make in the Briefs, have not been considered and are deemed to be waived. *See* 37 C.F.R. § 41.37(c)(1)(vii).

³ The rejections of claim 8 under 35 U.S.C. § 102(a) as being anticipated by Kuwabara (US Patent 6,023,518) and claims 9, 10, 29 and 31-33 under 35 U.S.C. § 103(a) as being unpatentable by Kuwabara have been withdrawn (Ans. 6). Additionally, the rejection of claims 9 and 32 under 35 U.S.C. § 102(b) as being anticipated by Sone has been withdrawn (Ans. 6).

⁴ We refer to the most recent Appeal Brief, filed February 16, 2006, and the most recent Reply Brief, filed July 24, 2006, throughout this opinion.

⁵ We refer to the most recent Examiner’s Answer mailed May 19, 2006, throughout this opinion.

OPINION

The Indefiniteness Rejection

We first consider the Examiner's rejection of claim 28 under 35 U.S.C. § 112, ¶ 2 as being indefinite for failing to particularly point out and distinctly claim the subject matter which Appellants regard as the invention. The Examiner finds claim 28 is indefinite because it depends from withdrawn claim 12 (Ans. 3). Appellants argue that the non-entered Amendment⁶ changing the dependency to claim 27 overcomes the rejection (App. Br. 4).

At the outset, we note that claim 12 has been withdrawn from consideration as being drawn to a non-elected invention.⁷ Similarly, claim 28 should have been withdrawn from consideration.⁸ Additionally, claim 12 recites that a surface portion of the electric circuit board is positioned against the coil by adhesion, and claim 28 further limits the type of adhesion to glue. There is a reasonable degree of clarity and particularity with regards to the recitation in claim 28 regarding the type of adhesion, and we see no ambiguity.

For the foregoing reasons, we will not sustain the Examiner's indefiniteness rejection of claim 28.

The Anticipation Rejection Based on Lee

We next consider the Examiner's rejection of claims 8, 9, 31, and 32 under 35 U.S.C. § 102(b) as being anticipated by Lee. "A claim is

⁶ See the Advisory Action, mailed September 2, 2004.

⁷ See Paragraph 6 of the Non-Final Office Action mailed August 27, 2003.

⁸ See 37 C.F.R. § 1.142(b) and MPEP § 821.

anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.”

Verdegaal Bros, Inc. v. Union Oil Co. of Calif., 814 F.2d 628, 631 (Fed. Cir. 1987). Appellants group the arguments according to the following claims: (1) 8 and 9 and (2) 31 and 32 (App. Br. 9-10; Reply Br. 4-5). Below, each group will be addressed.

Claims 8 and 9

Regarding representative independent claim 8,⁹ the Examiner indicates that Lee discloses all the claimed subject matter (Ans. 3). Appellants argue that element 3b in Lee is not an electronic circuit board. Specifically, Appellants contend the recited electric circuit board in Lee is not shown and that the purpose of element 3b is to vibrate in response to a given frequency sent by the printed circuit board not shown (App. Br. 9-10).

Lee discloses the second vibration element 3b is “also used as a circuit board for the coil 8” (Lee, col. 3, ll. 50-51 and col. 4, l. 17). This disclosure clearly states that element 3b serves two functions – one as a vibration member to generate sounds (Lee, col. 5, ll. 15-16) and another as a circuit board for the coil (Lee, col. 3, ll. 49-51 and col. 6, ll. 10-16). Additionally, Lee discloses two circuit boards: (1) the vibration element 3b and (2) the printed circuit board for the cellular or pager phone (Lee, col. 4, ll. 15-17). The fact that more than one circuit board is disclosed does not detract from the explicit disclosure in Lee that element 3b is a circuit board for the coil

⁹ Appellants argue claims 8 and 9 as a group (App. Br. 9-10; Reply Br. 4). Accordingly, we select claim 8 as representative. *See* 37 C.F.R. § 41.37(c)(1)(vii).

(Lee, col. 3, ll. 41-51) and fully meets the limitation to an electric circuit board in claim 8.

For the foregoing reasons, Appellants have not shown error in the anticipation rejection of independent claim 8 based on Lee. Accordingly, we sustain the rejection of claim 8 and claim 9 which falls with claim 8.

Claims 31 and 32

Regarding representative independent claim 31,¹⁰ Appellants argue that Lee does not include signal processing electronics (Reply Br. 4). This argument was not timely raised in the Appeal Brief, but rather was brought up for the first time in the Reply Brief. As such, this argument is waived.¹¹ In any event, the respective electric circuit board in Lee (member 3b) includes electronics which are used to convert or process the electrical signals into acoustic energy (Lee, col. 3, ll. 41-51, col. 4, ll. 7-17, col. 5, ll. 38-44, and col. 6, ll. 10-16). Additionally, given the breadth of the recited “signal processing electronics” limitation, the electronics of the electric circuit board 3b in Lee that convert and process the electric signals to acoustic energy amply disclose signal processing electronics.

For the foregoing reasons, Appellants have not shown error in the anticipation rejection of independent claim 31 based on Lee. Accordingly, we sustain the rejection of claim 31 and claim 32 which falls with claim 31.

¹⁰ Appellants argue claims 31 and 32 as a group (Reply Br. 4-5). Accordingly, we select claim 31 as representative. *See* 37 C.F.R. § 41.37(c)(1)(vii).

¹¹ *See Optivus Tech., Inc. v. Ion Beam Appls. S.A.*, 469 F.3d 978, 989 (Fed. Cir. 2006) (“[A]n issue not raised by an appellant in its opening brief ... is waived.”) (citations and quotation marks omitted).

The Anticipation Rejection Based on Sone

We finally turn to the Examiner's rejection of claims 8, 10, 11, 27, 29-31, and 33-36 under 35 U.S.C. § 102(b) as being anticipated by Sone. Appellants group the arguments according to the following: (1) claims 8, 10, and 30; (2) claims 11 and 34; (3) claims 27 and 35; (4) claims 29, 31, and 33 (App. Br. 5-9; Reply Br. 2-4); and (5) claim 36. Below, each group will be addressed.

Claims 8, 10, and 30

Regarding representative claim 8,¹² the Examiner's rejection finds that Sone discloses all the claimed subject matter (Ans. 4). Appellants argue that Sone does not disclose an electronic circuit board. Specifically, Appellants take the position that plate 40 in Sone is part of a closed magnetic circuit and that none of the elements selected by the Examiner (40, 42, 44, 48, 50, 52) make up an electric circuit board. In Appellants' view, the electric circuit board in Sone is actually designated by element 62 and is not positioned against the coil as claimed (App. Br. 5-7; Reply Br. 3).

Sone discloses a plate 40 insulated by film 48 that includes conductive patterns 50 and 52 (Sone, col. 4, ll. 10-43; Figs. 1-4). The conductive patterns 50 and 52 are printed on both sides of the plate 40 and create circuitry used for mounting and interconnecting components of electrical equipment (Sone, col. 4, ll. 31-43 and col. 6, ll. 65-67). The film 48 insulates the patterns 50 and 52 from the plate 40 (Sone, col. 4, ll. 28-31 and

¹² Appellants argue claims 8, 10, and 30 as a group (App. Br. 5-8). Accordingly, we select claim 8 as representative. *See* 37 C.F.R. § 41.37(c)(1)(vii).

col. 6, ll. 15-19). Hence, the plate 40, film 48, and patterns 50 and 52 all interconnect structurally to form an electric circuit board. Moreover, there is nothing in the Specification that excludes the recited electric circuit board from comprising multiple interconnected structural elements, such as a laminate. Thus, the broadest reasonable construction of the term, “electric circuit board,” in light of the Specification would include such multiple interconnected structural elements. Additionally, irrespective of the Examiner’s statement that the printed circuit board 62 “is not included in the Office Action” (Ans. 6), the circuit board 62 along with the plate 40, film 48, and patterns 50 and 52 all make up parts of an electric circuit board as the printed circuit board 62 in Sone is soldered and electrically connected to the plate (Sone, col. 6, ll. 24-27; Fig. 5). Moreover, as the plate 40 also has a surface portion (top surface of 40 shown in Figure 1) positioned against the coil in a substantially perpendicular manner, Sone discloses at least a surface portion of an electric circuit board positioned against the coil in a substantially perpendicular relationship to the axis defined by the coil opening as recited in claim 8.

Appellants also argue that the plate 40 is part of the closed magnetic circuit and cannot be a part of an electric circuit board (App. Br. 5-6; Reply Br. 3). As previously stated, we disagree that the plate cannot be part of the electric circuit board. That is, the plate 40 serves more than one function. While acting as part of the magnetic circuit, the plate additionally serves as a substrate or base for printing the insulating film and the conductive patterns -- all of which define the electric circuit board. The plate, therefore, forms a portion of an electric circuit board.

For the above reasons, Appellants have not shown error in the anticipation rejection of claim 8 based on Sone. Accordingly, we sustain the rejection of claim 8 and claims 10 and 30 which fall with claim 8.

Claims 11 and 34

Representative claim 11¹³ further recites the electric circuit board has an opening and the opening is substantially aligned with the coil opening. The Examiner indicates how this limitation is fully met by Sone (Ans. 4). Appellants repeat the arguments made regarding claim 8 and the plate 40 in Sone not being an electric circuit board (App. Br. 8). In Appellants' view, since the plate 40 is not an electric circuit board, Sone does not disclose the electric circuit board has an opening (App. Br. 8). Our previous discussion pertaining to the disclosure of Sone and how the plate 40 is part of an electric circuit board applies equally here. We, therefore, incorporate that discussion by reference. As the plate 40 makes up a portion of the electric circuit board in Sone, the circuit board includes an opening (Sone, col. 5, ll. 19-20; Fig. 1) substantially aligned with the coil opening as recited in claim 11.

For the above reasons, Appellants have shown no error in the anticipation rejection of claim 11 based on Sone. Accordingly, we will sustain the anticipation rejection of claim 11 and claim 34 which falls with claim 11.

¹³ Appellants argue claims 11 and 34 as a group (App. Br. 8). Accordingly, we select claim 11 as representative. See 37 C.F.R. § 41.37(c)(1)(vii).

Claims 27 and 35

Claim 27 further recites the surface portion of the electric circuit board is positioned against the coil by adhesion. Claim 8, from which claim 27 depends, also recites the surface portion is positioned against the coil in a substantially perpendicular relationship to the axis defined by the coil opening. The Examiner indicates how this limitation is fully met by Sone through the connection of the lead wires 22 and 24 to coil and plate (Ans. 4). Appellants argue that the core 6, not the coil, is adhered or connected to the plate 40 by a screw. Based on this disclosure, the Appellants contend that Sone does not disclose the surface portion of the electric circuit board is positioned against the coil by adhesion (Reply Br. 4). Although this argument was raised for the first time in the Reply Brief and is technically waived,¹⁴ we nonetheless address this contention. Upon review, we find that Sone does not disclose or is silent regarding whether *the surface portion* of the electric circuit board that is positioned against the coil in a substantially perpendicular relationship to the axis defined by the coil opening is also positioned against the coil by adhesion.

Based on the above reasons, we will not sustain the anticipation rejection of claim 27 and claim 35 which is commensurate in scope.

¹⁴ See *Optivus*, 469 F.3d at 989.

Claims 29, 31 and 33

Representative claim 29¹⁵ further recites the electric circuit board includes electronics for signal processing. The Examiner indicates how this limitation is fully met by Sone (Ans. 4). Appellants argue that the plate 40, film 48, and conductive patterns 50 and 52 do not include electronics for signal processing (App. Br. 7-8; Reply Br. 3).

We agree with Appellants that components 40, 48, 50, and 52 in Sone are not electronics for signal processing. However, as stated above with regard to claim 8, the scope and breadth of the recited electric circuit board does not preclude multiple interconnected structural elements that include circuit board 62 in Sone. That is, Sone discloses an electric circuit board that includes plate 40, film 48, patterns 50 and 52, *and* board 62. Sone discloses the device converts electrical signals to sound, and thus the board 62 must include some electronics for signal processing (Sone, col. 1, ll. 6-9). Additionally, Appellants admit that any electronics in Sone would be on the printed board 62 (Reply Br. 3). In turn, component 62 of the electric circuit board in Sone includes electronics for signal processing as claim 29 recites.

For the above reasons, Appellants have not shown error in the anticipation rejection of claim 29 based on Sone. Accordingly, we sustain the rejection of claim 29 and claims 31 and 33 which fall with claim 29.

¹⁵ Appellants argue claims 29, 31 and 33 as a group (App. Br. 7; Reply Br. 4-5). Accordingly, we select claim 29 as representative. *See* 37 C.F.R. § 41.37(c)(1)(vii).

Claim 36

Claim 36 further recites the electric circuit board is electrically connected to the coil through lead wires. The Examiner indicates how this limitation is fully met by Sone (Ans. 5). Appellants argue that the board 62 is not electrically connected to the coil through lead wires but rather through soldering the board 62 to plate 40 (App. Br. 9). Our previous discussion pertaining to Sone and how the plate 40, film 48, patterns 50 and 52, and board 62 are parts of the electric circuit board applies equally here. We, therefore, incorporate that discussion by reference. As the plate 40 and conductive patterns 50 and 52 of Sone are part of the electric circuit board, Sone discloses a portion of the electric circuit board is electrically connected to the coil through lead wires 22 and 24 as recited in claim 36 (Sone, col. 6, l. 61 – col. 7, l. 5; Figs. 1, 3 and 5).

Based on the above reasons, Appellants have not shown error in the anticipation rejection of claim 36 based on Sone. Accordingly, we sustain the rejection of claim 36.

New Grounds of Rejection Under 35 U.S.C. §102(b)

Under 37 C.F.R. § 41.50(b), we enter a new ground of rejection under 35 U.S.C. §102(b) for claims 8, 27, 29, 31, and 35.

The following is a quotation of the appropriate paragraph of 35 U.S.C. § 102 that forms the basis for the following rejections:

A person shall be entitled to a patent unless —

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States.

Claims 8, 27, 29, 31, and 35 are rejected under 35 U.S.C. § 102(b) as being anticipated by *The ARRL Handbook for Radio Amateurs 1993* (“the ARRL Handbook”).

Figure 57 of the ARRL Handbook (Page 31-25) is reproduced below:

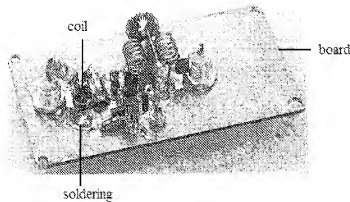


Figure 57 depicts a preamplifier with a coil and other circuit elements mounted on a board.

As shown above, the ARRL Handbook discloses a coil assembly comprising a coil (see coil reference line) having a coil opening defining an axis therethrough and an electric circuit board (see board reference line) wherein at least a surface portion is positioned against the coil in a substantially perpendicular relationship to the axis (*The ARRL Handbook*, 25; Fig. 57). While Figure 57 does not state the board is an electric circuit board, the plate clearly functions as part of the circuit to connect the electrical components shown into an integrated preamplifier. Thus, giving the term, “electric circuit board,” its broadest reasonable interpretation, the board shown in Figure 57 is an electric circuit board.

Additionally, we note that Figure 57 shows a preamplifier, and claim 8 recites “a coil assembly for an electroacoustic transducer.” The phrase, “for an electroacoustic transducer,” is language relating to the function or intended use of the coil assembly. As courts have stated, “the absence of a disclosure relating to function does not defeat the Board’s finding of anticipation. It is well settled that the recitation of a new intended use for an old product does not make a claim to that old product patentable.” *In re Schreiber*, 128 F.3d 1473, 1477 (Fed. Cir. 1997). Thus, while Figure 57 and its description do not disclose the coil assembly being used in an electro-acoustic transducer, the disclosed assembly of Figure 57 is nonetheless capable of functioning as a coil assembly for an electro-acoustic transducer if it were so employed. Moreover, the coil assembly in Figure 57, as discussed above, includes all the recited structural limitations of claim 8. We, therefore, find that the coil assembly in Figure 57 of the ARRL Handbook anticipates claim 8.

Regarding claims 27 and 35, Figure 57 shows a surface portion of the electric circuit board is positioned against the coil by adhesion or soldering (see soldering reference line).

Regarding claims 29 and 31, both include the additional limitation of the electric circuit board having electronics for signal processing. As the device in Figure 57 is a preamplifier, there are ample electrical components that perform signal processing, including an output filter (the ARRL Handbook, 26). Thus, Figure 57 of the ARRL Handbook meets the limitations of the “electric circuit board includes electronics for signal processing” recited in claim 29 and the “electric circuit board including signal processing electronics” recited in claim 31.

Although we decline to reject every claim under our discretionary authority under 37 C.F.R. § 41.50(b), we emphasize that our decision does not mean the remaining claims are patentable over the ARRL Handbook. Rather, we merely leave the patentability determination of these claims to the Examiner. *See* MPEP § 1213.02.

DECISION

We have sustained the Examiner's rejections with respect to claims 8-11, 29-34 and 36. We have not, however, sustained the Examiner's rejections of claims 27, 28, and 35. Therefore, the Examiner's decision rejecting claims 8-11 and 27-36 is affirmed-in-part. We have, however, entered a new ground of rejection under 37 C.F.R. § 41.50(b) for claims 8, 27, 29, 31, and 35.

This decision contains a new ground of rejection pursuant to 37 C.F.R. § 41.50(b). Section 41.50(b) provides that "[a] new ground of rejection . . . shall not be considered final for judicial review."

This section also provides that the Appellants, **WITHIN TWO MONTHS FROM THE DATE OF THE DECISION**, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:

(1) *Reopen prosecution*. Submit an appropriate amendment of the claims so rejected or new evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the proceeding will be remanded to the examiner. . . .

Appeal 2007-4432
Application 09/980,430

(2) *Request rehearing.* Request that the proceeding be reheard under § 41.52 by the Board upon the same record. . . .

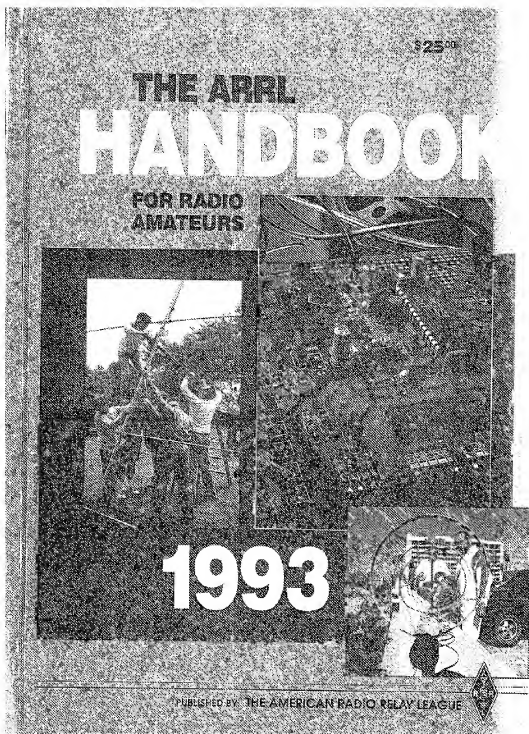
No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED-IN-PART
37 C.F.R. § 41.50(b)

KIS

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EVIDENCE APPENDIX

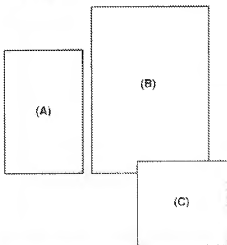


THE ARRL HANDBOOK FOR RADIO AMATEURS

Published by:

The American Radio Relay League
Newington, CT 06111 USA

Seventeenth Edition



Cover photos

A - At the W3CK Field Day site in eastern Pennsylvania, N3LAI fastens the boom to a mast with the help of many friends. (Photo by N3GWF)

B - The ChipTaker project is new to this year's Handbook. Look for one voice memory player in the Digital Equipment chapter.

C - Here's a view down the barrel of a 1296-MHz local Yag antenna. (Don't do this with a transmitter connected!) In the background is the site of the 1992 West Coast VHF/UHF Conference and the Pacific Ocean. (Photo by Gary Joe, W6QDA)

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Linear Transverters for 144 and 220 MHz

The CW and SSB portions of the 160-MHz HF bands have proved to be a lifeline during the past few years. Although there are plenty of commercially made CW transceivers for 160 MHz, there are no SSB gear for 160 MHz; there are 80-Watt models for 220, 300 W Drexels, WB9YU reports.

Most of both the linear transceivers and the CW-only units are designed for the standard 50- Ω load shown in Fig. 4, although some CW-only units can handle 75- Ω . These projects are for 50- Ω loads.

I'll describe 28-MHz transceiver as a CW HF rig for 144- or 202-MHz operation. The circuit is simple enough that construction is a less complicated task than building a complete transceiver, and all of its major features of the HF rig (such as a variable capacitor, stable VFO and good audio) are included. The circuit diagram (Fig. 5) contains additional information about components and values.

This transceiver theory, although basic, may be used for many HF segments. The theory was developed primarily to cover the lower portion of each band (144-MHz CW and SSB, and 220 to 221 MHz). A 12-V power supply and an antenna are the only other equipment necessary to complete the HF station.

The complete transmitter design includes a collection of hand-crafted components that should be easily reproducible. Although the text and illustrations contain the 220-MHz transmitter, component values are given for the 144-MHz build as well. Except for the local oscillator (LO), details are common to both designs. The receive converter has a 0.6 dB noise figure and an overall conversion gain of 28 dB. These figures were verified on an HP414A noise-figure meter with an HP446A noise source. Transistors connected

power output is a conservative 1 W under linear operation. The companion amplifier produces 8 to 10 W of linear output power. Much care was taken to make the transmitter chain as clean as possible, and the regenerative converter incorporated techniques to maximize sensitivity and dynamic range.

CIRCUIT DESCRIPTION

Fig. 41 shows the transverse block

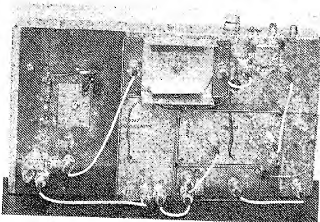
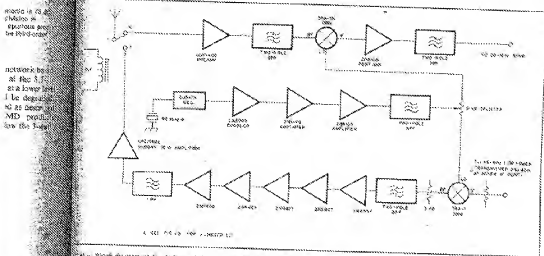


Fig. 40 — The 144 or 220 foot transporter is built using a modular unit approach. Each segment is forced and positioned on a concrete path (interconnecting of about 100 ft. of 60 ft. concrete slabs).



4 - Block diagram of the test and DQ-MMC hardware. All blocks but the local processor are common to both boards.

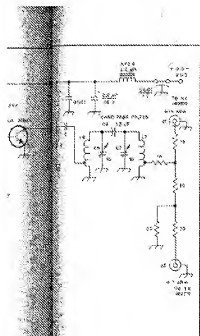


FIG. 43. Receiver circuit. The input stage is a 100k resistor and a 10pF capacitor. The output is connected to a 100k resistor and a 10pF capacitor. The circuit is powered by a 12V battery and a 100k resistor. The output is connected to a 100k resistor and a 10pF capacitor.

ing receive and transmit. The filter, a resistive power divider and a double-tuned band-pass filter, are used to drive the transmit and receive paths. Resistive pads upstream of the I/O pads to the proper level while providing 50-ohm impedance for the mixer input. Although a similar design could be designed for 144 MHz, a three-stage 28-MHz oscillator is shown schematically in Fig. 43. The 144-MHz transmitter uses a 10-MHz series resonant crystal (Y1) to set frequency multiplicity. Oscillator output is amplified by Q2 and Q3 used to set the device necessary to drive both the transmit and receive outputs. I/O output is used by a double-tuned band-pass filter. The filter, a resistive power divider is used to drive the transmit and receive paths again, pads attenuate the signal to proper level. With the filters properly adjusted, all the filter outputs from the I/O are about 10 dB below the fundamental. Fig. 44 shows the spectral output from the I/O drive circuit.

Transmit Converter

The 144- and 220-MHz receive components are identical, except for the tuned

circuit in the front end. In each case, the components consist of a GaAsFET preamplifier, a mixer/diodes circuit and an optional 28-MHz post amplifier. The mixer/diodes and post amplifier circuit are the same, regardless of band. Each of the three receive converter blocks is built into a separate module. This was done to facilitate experimentation and development of each stage. Of course, it is possible to build all three circuits in one box. This subject will be addressed in the construction portion of this article.

Mixer

The heart of the receive component is a Mini-Circuits SRA-1H high-level, doubly balanced mixer (DBM). See Fig. 45. This mixer requires an LO injection level of +17 dBm, compared with the +7 dBm injection level required for standard mixers. The high-level mixer offers superior strong-signal handling characteristics while maintaining the port-to-port isolation, image suppression and simplicity inherent to a DBM. The SRA-1H is moderately priced and available in small quantities directly from the manufacturer.

Reactive terminations can ruin the excellent IMD characteristics of a DBM-1H. The IF port, in particular, is most sensitive to a nonresistive 50-ohm termination. Anything short of a 20-dB resistive pad at the IF port will result in increased IMD products and a lower third-order intercept point. Feeding the output of a DBM directly into a narrowband amplifier will decrease the mixer's third-order intercept point as compared to a carefully resistive termination. The dipler circuit shown in Fig. 45 represents one solution to the problem of proper mixer termination. The dipler's low-pass response presents a 20-dB return loss at 28 MHz and terminates higher frequencies into 50 ohms.

RF Preamplifier

A low-noise, high-dynamic-range GaAsFET preamplifier is used in front of the mixer to overcome mixer conversion loss. The GaAsFET device offers excellent performance, compared with most bipolar and MOSFET, and designs abound.¹⁴ The circuit in Fig. 46 has proven reliable during many hours of on-the-air operation. This simple design offers a noise figure of 0.4 dB, as measured on an HP8570A noise-figure meter with the HP848A noise source. This noise figure is much lower than the feed loss preceding the preamplifier. Performance is exceptional for all applications short of in-

terview EMI testing. A 30-mA bias output scheme affirms signal-handling capability. The third-order intercept point is +21 dBm. Gain is 24 dB.

The double-tuned filter between the preamp and mixer provides a reasonable degree of filtering. A trap (L2) is used to attenuate the 164-MHz (188 MHz for the 144-MHz version) and 220-MHz for the 144-MHz version. A comb line or helical filter might be used if greater selectivity is required.

28-MHz Post Amplifier

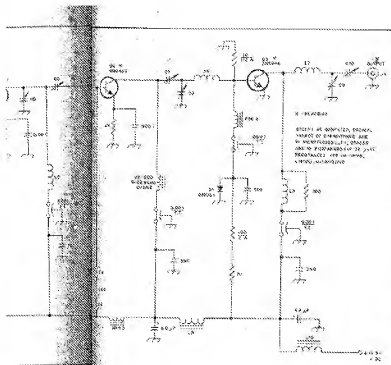
For more sensitive applications, a 28-MHz post amplifier is not necessary. It serves to amplify the 28-MHz IF signal to increase S-meter readings. The amplifier is among several of the "big gun" VHF stations in southeastern Pennsylvania, so high dynamic range is essential to avoid overload problems. The receiver component operates directly without any post amplification, thereby preserving the IF receiver's dynamic range.

The 28-MHz post amplifier shown in Fig. 46 has been included here for those operators fortunate enough to live away from strong in-band signals. The IN5109 is usually available and provides good performance at low cost. In this circuit, the device is biased to provide 13-dB gain with a third-order intercept point of +46 dBm. The design focuses a tuned input circuit and a broadband output transformer. A double-tuned band-pass filter at the output serves a dual signal for the IF receiver. Fig. 47B shows the swept frequency response of the post amplifier.

If you live in an area with local signals, you want to use a post amplifier, a pad may be used between the post amplifier and the IF receiver to reduce the converter gain to a level that the IF receiver can handle. The value of attenuation will depend on the IF receiver's ability to handle large signals. When you first connect the receive converter to the IF receiver, you will probably notice that the S-meter on the receiver moves up to 20 or higher (it depends on the nature of your specific receiver), even with no signals present. To determine the filter pad value for your application, place a variable step attenuator in the line between post amp and IF receiver and increase the attenuation until the IF receiver S-meter is just above zero. If you want to leave the step attenuator in the line, fine. If not, you can build a pad with the correct value from the attenuator tables given in Chapter 23 of this *Handbook*.

Transmit Converter

A schematic diagram for the 1-W transmit converter is shown in Fig. 46. The 144-MHz I/O (134-MHz I/O for the 144-MHz version) and 28-MHz signals are mixed in a Mini-Circuits SRA-1 standard-level DBM. A pad is necessary to limit the 28-MHz input to a maximum level of -10 dBm, ensuring good linearity and



was electrolyzed in a 0.1 M NaOH solution.

20' times, 0.230 sec.
dia. 7.4 at 51 from
top of 220 with good

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one inch wide dia.
2000 21 mo, 100 mm, 0.250-inch ID,
2000 21 mo, 100 mm, 0.250-inch ID,
one inch wide dia.
2000 21 mo, 100 mm, 0.250-inch ID,
one inch wide dia.
2000 21 mo, 100 mm, 0.250-inch ID,
one inch wide dia.
2000 21 mo, 100 mm, 0.250-inch ID,
one inch wide dia.

2000 (same for both bands).
 RT: -- Start with 28 min, 277 reads; very low
 proper: low. See text.
 RFLP: HFE4 -- 220 MHz; 1.3 pM (protein)
 modified 27 min; 44 MHz; 2.2 pM (protein)
 modified 27 min.
 27 -- Mini-Circuits 270-1 standard level
 doubly balanced mixer. Available (cheap)
 from the manufacturer. See text.

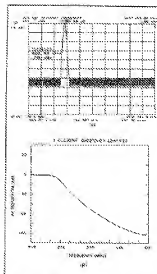


Fig. 25 — The plot in A shows the spectral output of the 144, 220-MHz transmitter oscillator after filtering. All harmonics and spurious emissions are at least 50 dB below the fundamental output. The transient converter meets superior FCC spurious-emission specifications. The plot in B is the swept-frequency response of the low-pass filter shown in Fig. 26.

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norm., 325-1000
2.

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40-45 of stable

is powered on, 12.5-V dc is applied to the L.O. and through K1 to the preamplifier and 28-MHz port amplifier. When J2 is closed, K1 removes power from the preamplifier and port amplifier and 12.5-V dc to the transmit circuit. When the transmit power amplifier is on, the L.O. is on and the transmit and receive is always on. When J2 is closed, K2 is also energized and the RP relay switches the antenna output of the VHT preamplifier input and the amplifier output. Relays of this type are readily available at flea markets and hamfests. Since most HF transceivers have separate transmit input and output relays, the relay switching for the HF transceiver is not required. The transmit transceiver is connected directly to the transmitter and the HF transceiver, while the amplifier output is unswitched directly to the converter input on the HF transceiver.

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three input surplus coaxial relays require a high voltage. While relays with any coaxial voltage could be used, it is a good idea to use relays and electronics from separate power supplies to avoid possible problems caused by voltage transients that occur when the relay coils are switched. The diode and capacitor connected across the relay coil power line help to alleviate transients.

CONSTRUCTION TECHNIQUES

Although this project is not intended for a first-time effort, anyone having a reasonable amount of VHF construction experience should encounter no difficulty. As with all VHF circuits, a certain amount

Proper grounding techniques, RF bypassing and shielding will ensure stable operation. Feedthrough grounding is used to provide a low inductance ground return on both sides of the PCB board. Basically, this involves drilling a hole through the PCB

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board at key points where components must have a good RF ground and installing a rivet or piece of no. 20 tinned wire soldered to both sides of the board. See Fig. 54. Check the schematic diagram for each circuit and install ground feed-throughs accordingly.

ensure a good RF bypass. Ceramic chip capacitors work best. These can be expensive, however, so they are used only where absolutely necessary. Epoxy encapsulated, miniature, monolithic ceramic capacitors work quite well as bypass capacitors.

output of each stage of the transmit component eliminates the likelihood of feed-back. Shielding was only found necessary on the transmit connector.

The variable capacitors used in each stage are miniature ceramic or plastic trimmers. The value of these capacitors is not critical as long as you use capacitors with maximum values close to those specified in the schematic diagram. For example, there are many capacitors available with a range from 2 to 8 pF or 2 to 32 pF. Any of these will work fine in circuits that call for 5- or 10-pF maximum values. Certain piston structures are most convenient for building the double-tuned band-pass filters. John

CONSTRUCTION TECHNIQUES

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VHF Radio Equipment 31-23

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Enol Chloride

and the local oscillator first; you'll need to prepare the rest of the other stages before soldering anything. Gather all of the heavy components and lay them out on board in order to plan adequate room for construction. Follow the schematic and refer to fig. 55 for an idea of how to lay out the board. Although the 40MHz LO for the 420-MHz transmitter shown is located in similar to the 336-MHz

Once the general layout scheme has been fixed, the components may be soldered onto the board, beginning with Q1. Keep components leads short, but leave enough room so you can change components if necessary. Make sure that the leads of Y1 are bent as far as possible and that the crystal will attach the box that the LFO will be fitted in. A dab of silicon sealant will hold the crystal in place.

Q1 and Q3 are mounted "belly up" with their leads sticking into the air. Note that Q1 and Q3 have a lead that is connected to the case. Solder this lead to the GND. The collector of Q4 is tied to the +5V and is connected with the leads facing the ground plane. Make sure that the case of Q4 does not touch the ground plane or

power for the L.O. enters the case through a feedthrough capacitor. Minimized RF chokes and bypass capacitors intercept the power line at each stage. In Fig. 55, these RF chokes and capacitors are arranged in a horizontal line that traverses the top of the board. Q1 is powered by an 8-V, three-terminal regulator. Various additional bypass capacitors are used to the IC body as possible.

Remove several unused sections. Cut off unused leads before soldering it into the board. T1 is a trifilar-wound transformer with 125-12 turns. See Fig. 38 for details. Although the transformer used here is wound by hand, a Minicircuits model may also be used.

Two amplifier units used two ceramic piston-type capacitors mounted through the chassis. These piston trimmers make adjustments to mount 1.6 and 1.7, common ceramic trimmers like those used in the rest of the agent will also work here. I had made them from a piece of double-sided, one-board material: separate 1.6 and 1.7, resulting over-coupling and causing a lot of interference. Although a 0.5-pF trimmer capacitor was used to couple the tuning sections, a 50-farad-glass trimmer capacitor made from two pieces of 0.03 enamel wire twisted tightly. You will work here.

one of the advantages of dead bag con-
dition — one that you should take ad-
vantage of — is that each stage can be
run individually. After you build the
collimator (Q1) and associated com-
ponents, you can test for 95 (or 116) A433

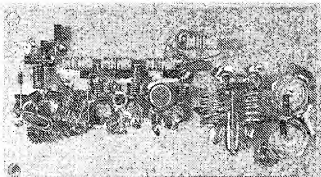


Fig. 53 — The PROSRA laser oscillator is laid out in the order it is drawn on the schematic diagram. Q1 is at the far left, Q4 is near the center of the beam. The modulator drive is on the right, with Q1 and Q2. The monitors used for the outer fields and Q3 are added near the glass exit window on the far right.

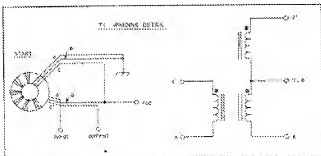


Fig. 56 — Winding details for T1 in the 100W/60 Hz. Label one end of some 6-inch pieces of enameled wire as shown. Holding all three wires flat, in parallel, begin threading the forceps starting with the unjoined end of the three wires. Completely wrap the third by feeding the entire group of wires in parallel. Once seven turns have been wound, use an ohmmeter to trace the unjoined ends. Label the end of wire A by A, and so on. After the windings have been properly labeled, remove the 25 ohm resistor.

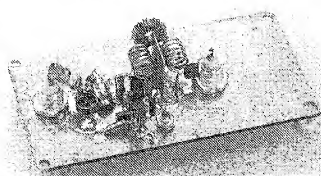


Fig. 67 — View of the VSM 21 preamplifier. The input components at the left of the board are mounted with as little lead length as possible to minimize losses.

output by capacitively coupling into a receiver or spectrum analyzer from the 50-ohm pad at the output of the stage. When you are sure Q1 is working, build the next stage and test it. Proceed classically building and testing each stage until you reach the final output stage.

When all of the IC stages are complete, check the operating frequency with a counter or spectrum analyzer. Tune each stage for maximum output. Tuning is somewhat insensitive, so retouch each stage after you have done the initial tuning. Each variable capacitor should have a definite peak. If you have a method of checking low power levels, check the output at the receiver and receiver ports. Power output should be as indicated on the drawings.

All other stages are constructed in a like manner. Lay the board out in advance, place at the input and work toward the output. Test each stage after you build it, and fix any problems before continuing to the next stage.

Preamplifier

The GUMMET transmitter requires special handling care because it is especially sensitive to static electricity. Before the transfer to the circuit last, use a grounded tip, low-temperature soldering iron. If a static-free work station is unavailable, ground yourself before removing the MG1402 from its protective package to prevent static buildup from destroying the device.

Although an MG1402 is specified, you can use other devices if you change the biasing resistors accordingly. Consult the reference listed at the end of this project before attempting a modification. The MG1402 is a fairly common transistor and is available from several of the suppliers listed in Chapter 34.

The general layout is shown in Fig. 57. Although BNC connectors were used here, Type-B or SMA connectors may be employed. A number of ground feedthroughs are used at points indicated on the schematic diagram. These feedthroughs are necessary for stable operation and optimum performance; they must be used. See Fig. 54.

Ceramic chip capacitors are mandatory for the source bypass on the MG1402. Do not attempt to substitute low-grade capacitors here! Chip capacitors provide a low-impedance source ground; this is of particular importance for stable operation with high-gain devices such as the microwave GUMMET used here. The MG1402 is mounted directly to the source bypass capacitors by its source leads. First, solder one end of each chip capacitor to the ground plane. Then solder one source lead to each chip capacitor. See the preamplifier project that appears earlier in this chapter for complete details of this mounting scheme.

The output filter is similar to the one described in the local-oscillator section. In

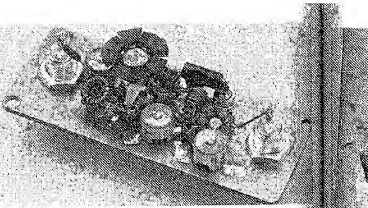


Fig. 56 — Circuit of the 2N5109 post amplifier. On using a precision fixed bias stack, the transistor case is tied to the collector, so the metal case must be positioned away from the case and nearby components.

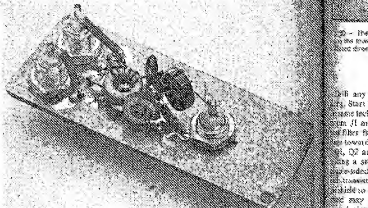


Fig. 59 — Circuit of the receiver mixer and diplexer filter. PG-174 cables are used between the receiver and input connectors.

this case, however, the coupling capacitor is a 0.3- to 1-pF trimmer. A toroidal coil is added for the 166-MHz image stop.

2N5109 Post Amplifier

The 2N5109 post amplifier shown in Fig. 58 requires little special care. More, however, the use of a precision fixed bias stack. Keep the heat sink away from the circuit board and other components since the 2N5109 case is tied to the transistor collector.

Receiver Mixer

The receiver mixer and diplexer filter may be housed in the enclosure, as shown in Fig. 59. The SRA-111 is first mounted on top of the circuit board with the pins protruding through to the component side. Carefully mark and drill eight holes using

a no. 59 drill bit. All holes on top of the board are drilled with a 1/8-inch drill. Turn the bit by hand to remove the burrs around the hole. This allows ample clearance where leads are soldered to the board. Debur the bottom of the hole with a fine file. The other pins are ground and should be soldered directly to the ground plane.

Transmit Converter

Construction of the transmit converter requires a little extra planning for component layout because of the number of components involved. Position the SRA-1 and MG1402 in a row with the pins for the SRA-1 protruding through to the component side. Extra room then is created for the SRA-1 pins to be connected to the ground plane. Refer to Fig. 60 for ideas on some of the

20 — The receiver mixer circuit board.

21 — The 2N5109 post amplifier circuit board.

22 — The receiver mixer and diplexer filter circuit board.

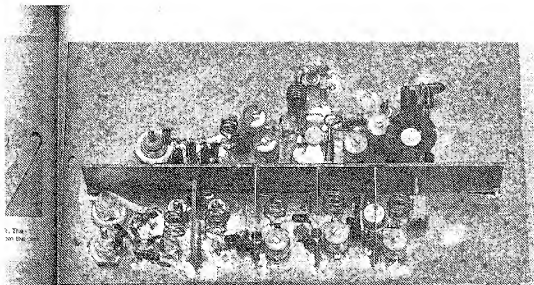


Fig. 10 - The underside of the board, showing the layout of the components.

Fig. 10 - The underside of the board, showing the layout of the components. Q1, Q2 and Q3 are arranged in the lower half of the board, below the horizontal slot. Q4 and Q5 are above that slot. Q6 is to the right. The two output leads of Q6 are soldered directly to the ground plane near the center of the board. The one-pass filter is between Q5 and the output terminals.

and any mounting holes as you go up, start by mounting the SRA-1 using the technique described above. Then use Fig. 10 to install the other two capacitors first, and then work stage-by-stage toward the output.

Q1, Q2 and Q3 should be shielded by using a small piece of sheet metal or etched metal circuit-board material over the transistor. Cut a U-shaped notch in sheet to clear the transistor case. Each shield may be soldered directly to the ground plane. Q1 and Q2 are mounted "flat," while Q3 and Q4 are mounted "upside up." Cut the Q3 and Q4 shields to 1/2 inch before soldering the shields in place. Note that Q1 and Q2 have their drain pins tied directly to the common case and must be soldered to the ground plane. The case of Q3, however, is mounted to the collector, so be sure to have adequate clearance between the case and the shield. Q4 must have a push-on, self-test wire. The heat sink should not have any other components. Again, keep the heat sink as short as possible.

It is a good idea to use a power resistor. It is a hole just large enough to pass the heat sink and transistor base through the back board. The emitter leads should be soldered flat on the component side of the board. Cut the collector and base leads off at the original length, while leaving the emitter leads full length. The heat sink of Q5 is made from a U-shaped piece of brass that is same material used for screw-head shields. Mount D1 on top of the heat sink for good thermal contact;

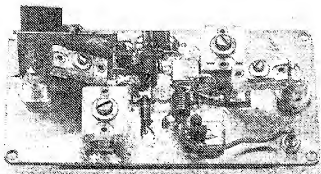


Fig. 11 - Show on the left, but the 2W 500V resistor and the small diode are on Q5. It is mounted to the corner of the board, input externally, is to the left, output to the right. Q1 and associated bias circuitry are below the diode, indicated in Fig. 10.

solder the ground end of D1 directly to the heat sink.

The value of R1 must be determined experimentally. Start with a 50-ohm, 2-W resistor. Measure the quiescent current of Q5 by inserting a milliammeter in the circuit at the cold end of L3. The quiescent current should be between 20 and 40 mA; adjust the value of R1 until proper bias is achieved.

The ultrasonic converter is tuned by applying 12.5-V dc, LC energy and a 28-MHz signal attenuated to provide -10 dBm at

the mixer input. Peak the double-tuned filter for maximum 220-MHz (or 144-MHz) output. If a spectrum analyzer is available, tune for a balance between maximum 220-MHz (or 144-MHz) energy and minimum spurious output. Next, peak C1 through C5. Alternately peak C5 and C6 for maximum output. C7, C8, C9 and C10 are adjusted in the same manner. Although a waveform may be used for tuning purposes, a spectrum analyzer tells the full story. Tune each stage for a compromise between output power and spectral purity.

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Harmonics are 60 dB down after filtering. After you're through adjusting the transmit converter, power output should be 1 watt.

Power Amplifier

The 10-W amplifier shown in Fig. 61 is mounted in its own chassis box. Ground feedthroughs are used beneath the 2N5946 carrier leads and at all various component grounds. The LM357 regulator IC must be attached to a heat sink. Bias should be adjusted for a quiescent current of 40 to 60 mA.

C5, C6 and C7 are Vishay metalized bulk-min capacitors. These capacitors provide an excellent low impedance RF ground and are designed to work at high current points. For stable operation, it is important that you use hook-style capacitors at these points.

The heat sink is fashioned from two U-shaped pieces of aluminum sheet. Be careful when mounting the heat sink; lateral pressure on the 2N5946 stud may break the transistor.

Summary

The transceiver modules are arranged on a chassis as shown in Figs. 40 and 61. Short runs of 50-ohm coaxial cable interconnect the units. Most of the dc power wiring is done underneath the chassis.

The 144-220-MHz transceiver represents a low-cost, modern approach to getting on the VHF bands. Circuit construction is straightforward, and the design makes use

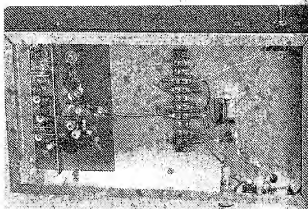


Fig. 61 — The transmit converter is mounted in a custom section of the chassis, equipped with a heat sink for the regulator, and power is drawn to a hook-style capacitor from the heat sink to each module.

of commercially available parts. The modular construction approach offers flexibility for easy troubleshooting and experimentation.

The author wishes to thank Ron Whitel, W4JANV, and other members of the Mount Airy VHF Radio Club "Packrats"

whose encouragement made this possible.

References

1. *Radio Shack Frequency Circuit Guide*, Radio Shack Publishing Co., Inc., 1978.
2. *Practical Electronics for Radio Hobbyists*, Design Engineering Office, Inc., Pomona, Calif., 1982.

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Fig. 62 — Schematic of the power line connection shown in Table 2.